THORIUM, RARE EARTH AND YTTRIUM CHEMICALS

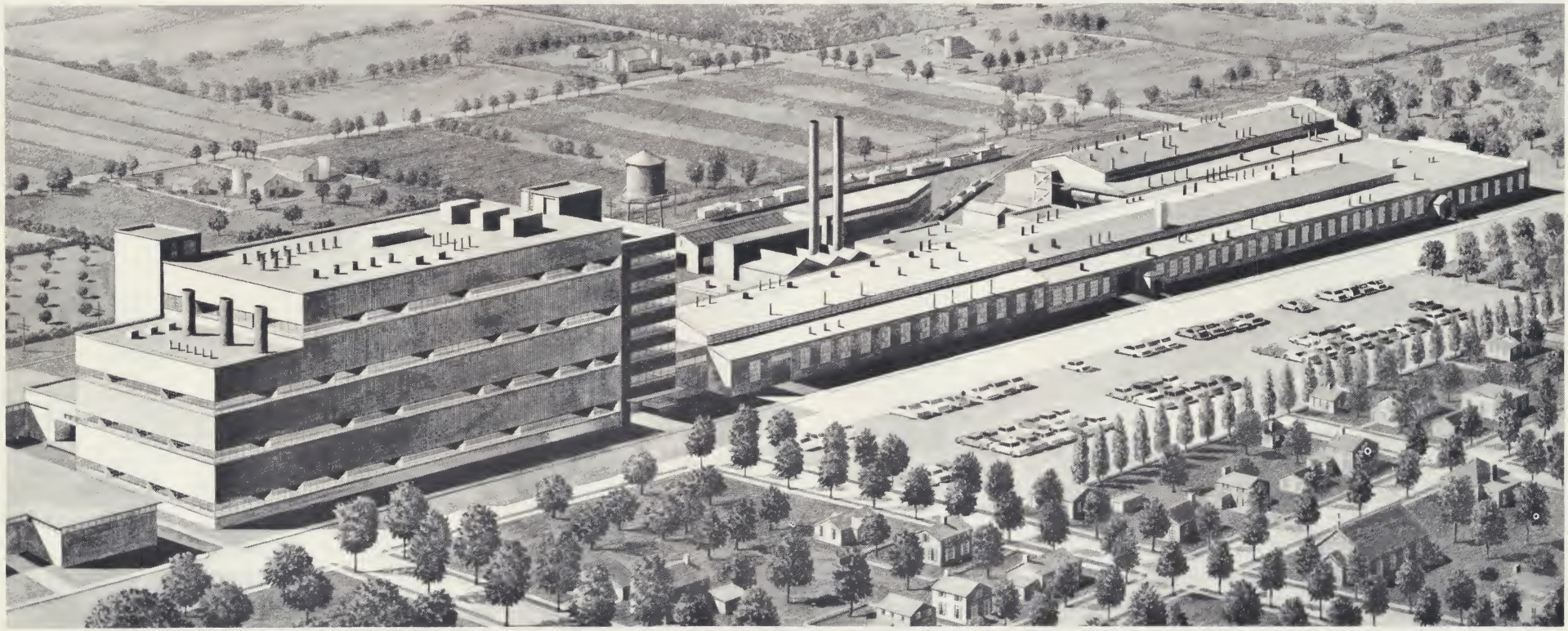
RARE EARTH DIVISION
American Potash & Chemical Corporation

TRONA®

American Potash & Chemical Corporation

Rare Earth Division

World's Largest Producer of Cerium, other Rare Earth and Thorium Chemicals



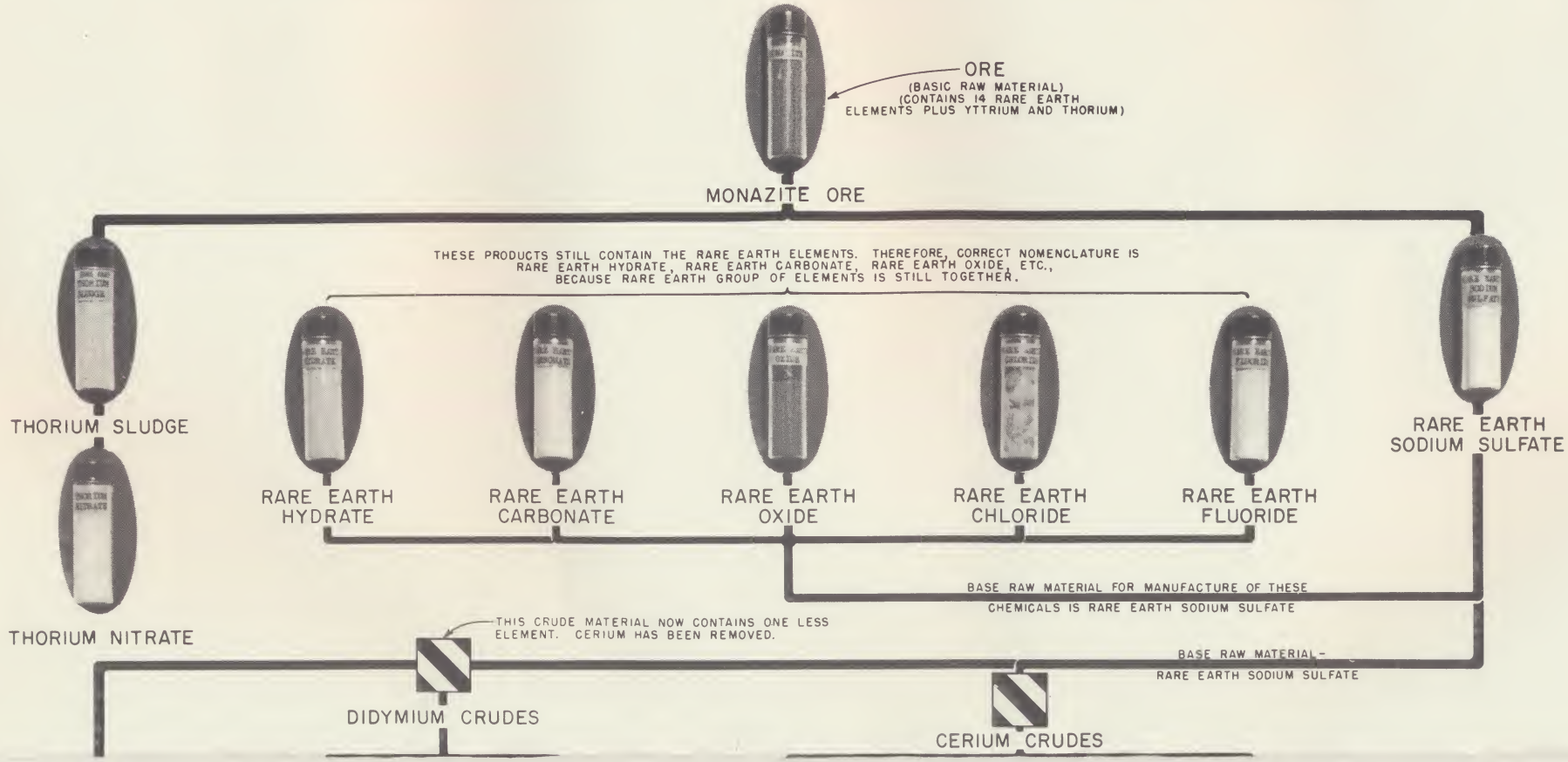
West Chicago, Illinois

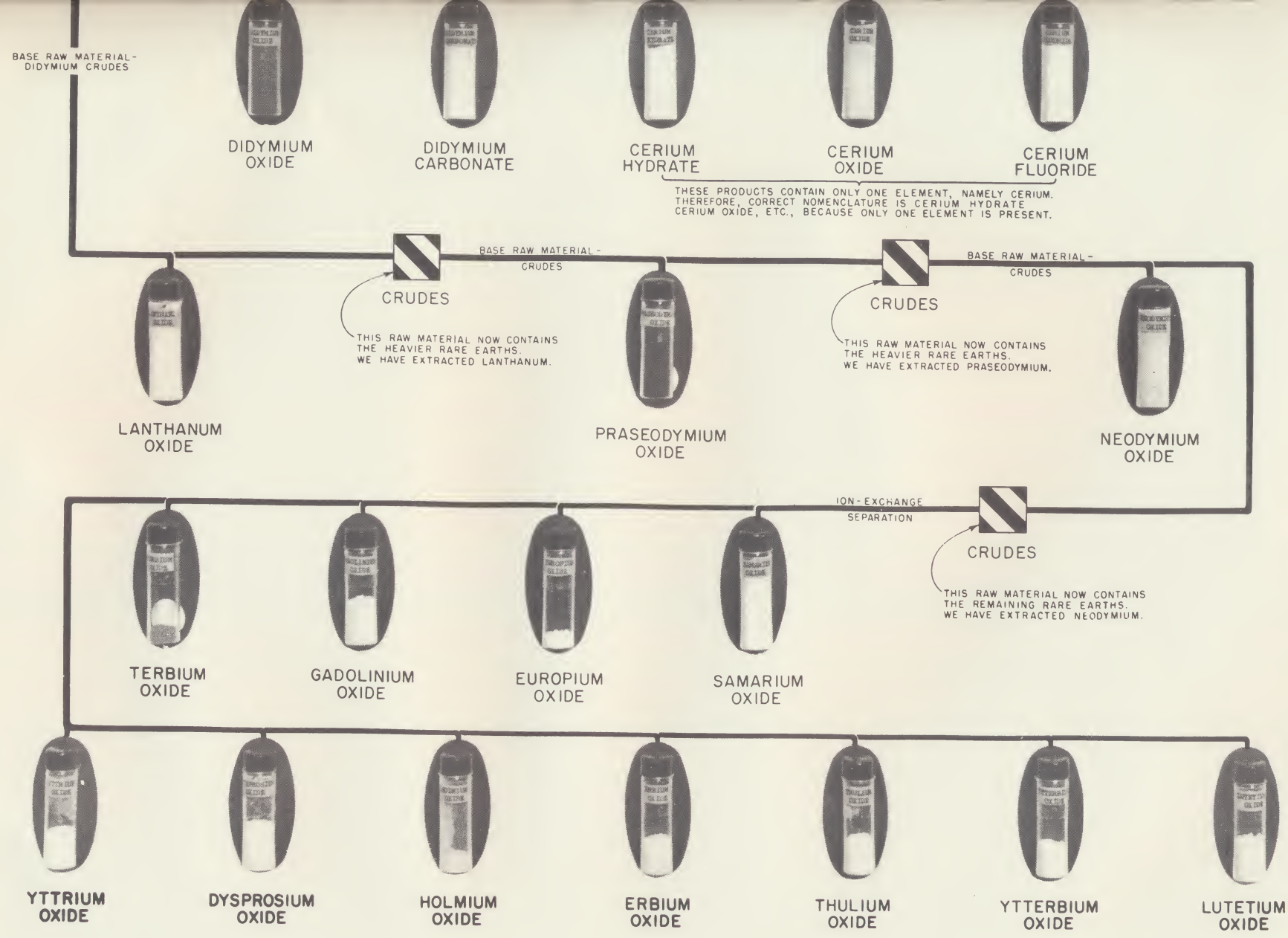
American Potash & Chemical Corporation

Rare Earth Division

West Chicago, Illinois

FLOW SCHEME
THORIUM AND RARE EARTH CHEMICALS




BASE RAW MATERIAL -
DIDYMIUM CRUDES
DIDYMIUM OXIDE
DIDYMIUM CARBONATE
CERIUM HYDRATE
CERIUM OXIDE
CERIUM FLUORIDE
THESE PRODUCTS CONTAIN ONLY ONE ELEMENT, NAMELY CERIUM.
THEREFORE, CORRECT NOMENCLATURE IS CERIUM HYDRATE
CERIUM OXIDE, ETC., BECAUSE ONLY ONE ELEMENT IS PRESENT.
BASE RAW MATERIAL -
CRUDES
CRUDES
THIS RAW MATERIAL NOW CONTAINS
THE HEAVIER RARE EARTHS.
WE HAVE EXTRACTED LANTHANUM.
LANTHANUM OXIDE
BASE RAW MATERIAL -
CRUDES
CRUDES
THIS RAW MATERIAL NOW CONTAINS
THE HEAVIER RARE EARTHS.
WE HAVE EXTRACTED PRASEODYMIUM.
PRASEODYMIUM OXIDE
NEODYMIUM OXIDE
ION-EXCHANGE
SEPARATION
CRUDES
THIS RAW MATERIAL NOW CONTAINS
THE REMAINING RARE EARTHS.
WE HAVE EXTRACTED NEODYMIUM.
TERBIUM OXIDE
GADOLINIUM OXIDE
EUROPIUM OXIDE
SAMARIUM OXIDE
YTTRIUM OXIDE
DYSPROSIUM OXIDE
HOLMIUM OXIDE
ERBIUM OXIDE
THULIUM OXIDE
YTTERBIUM OXIDE
LUTETIUM OXIDE

TECHNICAL DATA

CERIUM SALTS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

CERIUM SALT	CODE	FORMULA	COLOR AND FORM	SOLUBILITY Water§	Acids
CERIC HYDRATE	200,201,207	$CeO_2.xH_2O$	Yellow powder	I	SC
CERIC OXIDE	210,217	CeO_2	Flesh powder	I	SC
CEROUS OXALATE	227	$Ce_2(C_2O_4)_3.xH_2O$	White powder	I	SS
CEROUS CHLORIDE	237	$CeCl_3.6\text{-}7H_2O$	White to yellow lumps	S	S
CEROUS FLUORIDE	247	$CeF_3.0\text{-}1H_2O$	White powder	I	I
CEROUS NITRATE	277	$Ce(NO_3)_3.6H_2O$	White crystals	S	S
CERIC AMMONIUM NITRATE	280	$(NH_4)_2Ce(NO_3)_6$	Yellow crystals	S	S

Code numbers ending in 7 are high purity cerium materials; expressed as $\%CeO_2$ in the contained rare earth oxide their purities are 99.9% minimum. All other codes are "commercial grade" preparations having purities, expressed as $\%CeO_2$ in the contained rare earth oxide, of approximately 94 to 97%.

Shipping containers: Small lots in polyethylene-lined cans, or in bottles; larger quantities in polyethylene-lined fiber drums.

TYPICAL ANALYSES

The data below are not specifications, but represent typical analyses. Unless indicated by maxima or minima, the analyses reported are approximate and are intended only to indicate the nature of the material. All data in per cent.

CERIUM SALT	CODE	PURITY	CeO_2	Di_2O_3 ¶	Fe_2O_3	CaO	MgO	P_2O_5
HYDRATE	200	94-97%	79 min.	3.1 A	0.2 A			1.5 A
	201	94-97%	79 min.	3.1 A	0.1 A			0.5 A
	207	99.9%	79 min.	0.04 max.	<0.05 A			tr A
OXIDE	210	94-97%	90 min.	3-5 A	0.1 A			0.5 A
	217	99.9%	99.5 min.	0.05 max.	0.003 A			0.005 A
OXALATE	227	99.9%	50 min.	0.025 max.	0.002 A	tr A	0.05 A	
CHLORIDE	237	99.9%	45 min.	0.025 max.				
FLUORIDE	247	99.9%	79 min.	0.04 max.				
NITRATE	277	99.9%	39 min.	0.02 max.	0.003 A	0.1 A	0.1 A	0.005 A
AMMONIUM NITRATE	280	94-97%	28 min.	0.3 A	0.1 A			

A = approximate. tr = trace.

§ I = insoluble, SC = soluble strong or concentrated mineral acids, SS = slightly soluble, S = soluble.

¶ Di_2O_3 = didymium oxide = other rare earth oxides.

These illustrate the range of generally available cerium compounds. Other salts, and materials meeting other typical analyses can often be made.

C-1-1265ex

TECHNICAL DATA

DIDYMIUM SALTS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

These didymium salts are derived from monazite ore. "Didymium" refers to the mixture of rare earths obtained after removal of cerium and thorium from the natural mixture of rare earths found in the ore. This usage is consistent with American industrial nomenclature, and the symbol "Di" is used below to indicate "didymium". The composition of the rare earth mixture in didymium salts is quite consistent since these materials are produced by controlled processes from monazite ores obtained from large ore bodies. The average atomic weight of the contained rare earth metal is 143.

Shipping containers: Small lots in glass or plastic bottles, or polyethylene-lined cans; larger lots in polyethylene-lined fiber drums or steel drums.

DIDYMIUM SALT	CODE	FORMULA	COLOR AND FORM	SOLUBILITY Water§	Acids
DIDYMIUM CHLORIDE	400	$DiCl_3.6H_2O$	Flakes	VS	S
DIDYMIUM CARBONATE	411	$Di_2(CO_3)_3.xH_2O$	Pink powder	I	S
DIDYMIUM OXIDE	420	Di_2O_3	Brown powder	I	S
DIDYMIUM HYDRATE	440	Hydrated Di_2O_3	Pink powder	I	S
DIDYMIUM NITRATE	450	$Di(NO_3)_3.6H_2O$	Pink crystals	S	S
DIDYMIUM FLUORIDE	480	DiF_3	Nearly anhydrous pink powder	I	I

§ I = insoluble, SS = slightly soluble, S = soluble, VS = very soluble.

APPROXIMATE COMPOSITION OF THE CONTAINED RARE EARTH OXIDE IN THESE MATERIALS

	%		%
Lanthanum oxide, La_2O_3	40-45	Samarium oxide, Sm_2O_3	3-6
Cerium oxide, CeO_2	1-2	Gadolinium oxide, Gd_2O_3	2-4
Praseodymium oxide, Pr_6O_{11}	8-12	Yttrium oxide, Y_2O_3	0.2-1.0
Neodymium oxide, Nd_2O_3	32-37	Other rare earth oxides	1-2
			100

TYPICAL ANALYSES

The data below are not specifications, but represent typical analyses. Unless indicated, the analyses reported are approximate and are intended only to indicate the nature of the material. All data in per cent.

Code number	400 DIDYMIUM CHLORIDE	411 DIDYMIUM CARBONATE	420 DIDYMIUM OXIDE	440 DIDYMIUM HYDRATE	450 DIDYMIUM NITRATE	480 DIDYMIUM FLUORIDE
La_2O_3	20.7	29.5	42.8	36.5	16.9	36.5
CeO_2	0.5	1	1.4	1.2	0.2	1.2
Pr_6O_{11}	4.4	6.2	8.9	7.6	3.5	7.6
Nd_2O_3	14.6	21.1	30.6	26.0	12.0	26.0
Sm_2O_3	2.5	3.6	5.2	4.4	2.0	4.4
Gd_2O_3	1.5	2.3	3.3	2.8	1.3	2.8
Y_2O_3	0.2	0.3	0.4	0.3	0.2	0.3
Other REO	0.6	1	1.4	1.2	0.6	1.2
TOTAL REO (min.)	45	65	94	80	37	80
Fe_2O_3	0.1	0.05	0.1	0.1		0.4
CaO	0.5	0.2	0.4	1.4		0.2
MgO	0.05	0.02	0.04	0.6		0.2
Na_2O	0.50	0.02	0.04	0.2		-
SO_3	0.6	0.7	1.2	1.0		1.0
P_2O_5	0.005	0.003	0.007	0.05	0.01	0.05
Fluoride	-	-	-	-	-	26
Moisture	-	10 A	-	-	-	0.5
LOI*	-	34 A	4.5	17 A	-	-
Acid insol.	-	tr	1.0	-	-	-
Water insol.	0.5	-	-	-	nil	-

tr = trace. A = approximate. *LOI = loss on ignition.
REO = rare earth oxide

TECHNICAL DATA

GADOLINIUM SALTS

American Potash & Chemical Corporation TRONA

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Gadolinium salts are available in purities ranging from 95% to 99.9%. Lower purity salts are available as mixtures with samarium salts; for these materials refer to technical data on "Samarium-Gadolinium Salts".

These gadolinium compounds are separated from rare earth concentrates by advanced separation processes such as the ion exchange technique.

The oxide compositions given below are not specifications, but represent typical analyses. Unless indicated, these data are approximate and are intended only to indicate the nature of these materials.

GRADES OF GADOLINIUM SALTS

	PURITY DESIGNATION	95%	99%	99.9%	TOTAL RARE EARTH OXIDE
Code Number for Salts	OXALATE, $Gd_2(C_2O_4)_3.\underline{x}H_2O$	917	918.9	919.9	50%
	OXIDE, Gd_2O_3	927	928.9	929.9	98-99%§
	CHLORIDE, $GdCl_3.\underline{x}H_2O$	937	938.9	939.9	45%
	NITRATE, $Gd(NO_3)_3.6H_2O$	947	948.9	949.9	41%
	SULFATE, $Gd_2(SO_4)_3.8H_2O$		958.9	959.9	45%
	FLUORIDE, $GdF_3.0\text{-}2H_2O$		968.9	969.9	77%

Rare Earth Oxide Composition	GADOLINIUM OXIDE, Gd_2O_3	95% min.	99% min.	99.9% min.
	SAMARIUM OXIDE, Sm_2O_3	1-4%	up to 0.7%	0.1% max.
	NEODYMIUM OXIDE, Nd_2O_3	up to 2%	0.1% max.	
	EUROPIUM OXIDE, Eu_2O_3	0.1%	trace	
	YTTRIUM OXIDE, Y_2O_3	1-4%	0.1% max.	
	OTHER RARE EARTH OXIDES	up to 2%	trace	
	TOTAL	100%	100%	100%

§Gadolinium oxide is slightly hygroscopic and absorbs moisture and carbon dioxide from the air. The analysis given is for as-packed material.

Shipping containers: Small lots in glass or plastic bottles, or polyethylene-lined cans; larger lots in polyethylene-lined fiber drums.

These salts are typical of the gadolinium salts we make. Compounds not listed, and other purities can be made in some cases, and inquiry should be made for more specific information.

GD-163ex

TECHNICAL DATA

LANTHANUM SALTS

American Potash & Chemical Corporation TRONA

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

LANTHANUM SALT	CODES	FORMULA	COLOR AND FORM	SOLUBILITY Water§	Acids
LANTHANUM OXALATE	515 518 519	$La_2(C_2O_4)_3.8H_2O$	White powder	I	SS
LANTHANUM OXIDE	525 528 529	La_2O_3	Buff to white powder	I	S
LANTHANUM CHLORIDE	535 538 539	$LaCl_3.6H_2O$	White lumps or crystals	S	S
LANTHANUM NITRATE	545 548 549	$La(NO_3)_3.6H_2O$	White lumps or crystals	S	S
LANTHANUM ACETATE	555 558 559	$La(C_2H_3O_2)_3.\underline{x}H_2O$	White crystals	S	S
LANTHANUM HYDRATE	565 568 569	$La_2O_3.\underline{x}H_2O$	White powder	I	S
LANTHANUM CARBONATE	575 578 579	$La_2(Co_3)_3.0\text{-}1H_2O$	White powder	I	S
LANTHANUM FLUORIDE	585 588 589	$LaF_3.0\text{-}2H_2O$	White powder	I	I
LANTHANUM SULFATE	595 598 599	$La(SO_4)_3.8H_2O$	White powder	S	S

§ I = insoluble, SS = slightly soluble, S = soluble.

Shipping containers: Small lots in glass bottles, larger lots in polyethylene-lined fiber drums.

Typical analyses are given on the other side of this page.

TYPICAL ANALYSES

The data below are not specifications, but represent typical analyses. Unless indicated, the analyses reported are approximate and are intended only to indicate the nature of the material.

LANTHANUM SALT	CODE	% PURITY DESIGNATION	% La_2O_3	CeO_2 ppm	Pr_6O_{11} ppm	Other RE Oxides ppm	Fe ppm	% LOI*
OXALATE	515	99.9	52 min.	10 A	150 A	200 A	3 A	
	518	99.99	52 min.	5 A	50 A	10 A	0.5A	
	519	99.997	52 min.	tr	13 A	2.5 A	0.5A	
OXIDE	525	99.9	99-99.5*	20 A	300 A	400 A	5 A	
	528	99.99	99-99.5*	10 A	100 A	20 A	1 A	0.5-1*
	529	99.997	99-99.5*	tr	25 A	5 A	1 A	0.5-1*
CHLORIDE	535	99.9	45 min.	10 A	150 A	200 A	5 A	
	538	99.99	45 min.	5 A	50 A	10 A	1 A	
	539	99.997	45 min.	tr	13 A	2.5 A	1 A	
NITRATE	545	99.9	37 min.	10 A	150 A	200 A	5 A	
	548	99.99	37 min.	5 A	50 A	10 A	1 A	
	549	99.997	37 min.	tr	13 A	2.5 A	1 A	
ACETATE	555	99.9	47 min.	10 A	150 A	200 A	5 A	
	558	99.99	47 min.	5 A	50 A	10 A	1 A	
	559	99.997	47 min.	tr	13 A	2.5 A	1 A	
HYDRATE	565	99.9						
	568	99.99						
	569	99.997						
CARBONATE	575	99.9	70 min.	10 A	200 A	250 A	5 A	
	578	99.99	70 min.	7 A	70 A	10 A	1 A	
	579	99.997	70 min.	tr	15 A	3.5 A	1 A	
FLUORIDE	585	99.9	77 min.	10 A	250 A	250 A	5 A	
	588	99.99	77 min.	8 A	80 A	10 A	1 A	
	589	99.997	77 min.	tr	15 A	4 A	1 A	
SULFATE	595	99.9	45 min.	10 A	150 A	200 A	5 A	
	598	99.99	45 min.	5 A	50 A	10 A	1 A	
	599	99.997	45 min.	tr	13 A	2.5 A	1 A	

A = approximate; tr = trace.
*LOI = loss on ignition; lanthanum oxide is hygroscopic, resembling calcium oxide, and rapidly absorbs H_2O and CO_2 from the air. The analyses are for as-packed material.

Lower purity lanthanum materials are available on request.

TECHNICAL DATA

NEODYMIUM SALTS

American Potash & Chemical Corporation TRONA

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Neodymium salts are made in grades ranging from 65% to 99.9% purity. The most popular regular production materials are tabulated below by grade, code number, and composition of the contained rare earth oxide. The oxide compositions given below are not specifications, but represent typical analyses. Unless indicated, these data are approximate and are intended only to indicate the nature of these materials.

GRADES OF NEODYMIUM SALTS

Code Number for Salts	PURITY DESIGNATION	65%	85%	95%	99%	99.9%
	OXALATE, $Nd_2(C_2O_4)_3.xH_2O$		613	618		
	OXIDE, Nd_2O_3	621,622 *	623	628	629	629.9
	CARBONATE, $Nd_2(CO_3)_3.xH_2O$	631			639	639.9
	CHLORIDE, $NdCl_3.6H_2O$				649	649.9
	NITRATE, $Nd(NO_3)_3.6H_2O$				659	659.9
	SULFATE, $Nd_2(SO_4)_3.8H_2O$				669	669.9
	FLUORIDE, $NdF_3.0\text{-}2H_2O$	681			689	689.9

Rare Earth Oxide Composition						
	NEODYMIUM OXIDE, Nd_2O_3	65-70%	83-86%	95% min.	99% min.	99.9% min.
	CERIUM OXIDE, CeO_2	*	0.2%	nil	nil	
	PRASEODYMIUM OXIDE, Pr_6O_{11}	12-16%	10-12%	1-4%	0.1-0.4%	
	SAMARIUM OXIDE, Sm_2O_3	10-13%	0.1-0.5%	1-4%	0.1-0.4%	0.1% max.
	GADOLINIUM OXIDE, Gd_2O_3	3-5%	0.2%	trace	trace	
	OTHER RARE EARTH OXIDES	1-6%	2-4%	0.5-1%	0.5%	
	TOTAL	100%	100%	100%	100%	100%

*Codes 621 and 622 are essentially the same except for cerium content. Code 621 contains up to about 1% CeO_2 in the contained rare earth oxide, and Code 622 contains only traces of cerium.

Shipping containers: Small lots in glass or plastic bottles, or polyethylene-lined cans; larger lots in polyethylene-lined fiber drums or steel drums.

These salts are typical of the neodymium salts we make. Compounds not listed, and other purities can be made in some cases, and inquiry should be made for more specific information.

For lower purity, less expensive neodymium salts, see data on "Didymium Salts."

Typical analyses are given on the other side of this page.

TYPICAL ANALYSES

The data below are not specifications, but represent typical analyses. Unless indicated, the analyses reported are approximate and are intended only to indicate the nature of these materials. All data are in per cent. Contents of silica and phosphate range from nil to about 0.05% in the 65 and 85% grade materials. Non-rare earth impurities in the 99 and 99.9% grades are generally less than 0.01% each. For a more complete breakdown of rare earth impurities, see data in the table on "Grades of Neodymium Salts."

NEODYMIUM SALT	CODE	PURITY DESIGNATION	TOTAL RARE EARTH OXIDE	Nd_2O_3	Pr_6O_{11}	CaO	MgO	Fe_2O_3 + Al_2O_3	SO_3
OXALATE	613	85	45	38	4-5	0.1	0.1	0.1	0.05
	618	95	45	42.8	0.8	0.1	0.03	0.03	0.03
OXIDE	621	65	97-98*	63-64	8-10	0.6	0.06	0.3	0.6
	622	65	98-99*	63-64	8-10	0.07	0.05	0.05	0.05
	623	85	98-99*	83-86	10-12	0.3	0.1	0.2	0.05
	628	95	98-99*	93-95	1-4	0.2	0.05	0.05	0.05
	629	99	98-99*	98-99	0.4	nil to traces			
	629.9	99.9	98-99*	98-99	<0.1	nil to traces			
CARBONATE	631	65	70 min.	46-49	9-11	0.5	0.05	0.2	0.5
	639	99	70 min.	69	0.1-0.3	nil to traces			
	639.9	99.9	70 min.	70	<0.1	nil to traces			
CHLORIDE	649	99	45 min.	44.6	0.4-2	nil to traces			
	649.9	99.9	45 min.	45	0.2	nil to traces			
NITRATE	659	99	40	39.6	0.4-2	nil to traces			
	659.9	99.9	40	40	0.2	nil to traces			
SULFATE	669	99	45	44.6	0.4-2	nil to traces			
	669.9	99.9	45	45	0.2	nil to traces			
FLUORIDE**	681	65	77 min.	50-54	9-12	0.5	0.2	0.3	0.2
	689	99	77 min.	76	0.1-0.3	nil to traces			
	689.9	99.9	77 min.	77	<0.1	nil to traces			

* Neodymium oxide is somewhat hygroscopic and absorbs moisture and carbon dioxide from the air rather rapidly. The analyses given are for as-packed material. These oxides normally show up to 2% loss on ignition.

**Fluorine content is nominally 26% F.

TECHNICAL DATA

PRASEODYMIUM SALTS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Praseodymium salts are made by ion-exchange separation processes in grades ranging from 85% to 99.9% purity. The most popular regular production materials are tabulated below by grade, code number, and composition of the contained rare earth oxide. The oxide compositions given below are not specifications, but represent typical analyses. Unless indicated, these data are approximate and are intended only to indicate the nature of these materials.

GRADES OF PRASEODYMIUM SALTS

	PURITY DESIGNATION	85%	90%	99%	99.9%
Availability and Code Numbers for Salts	OXALATE, $Pr_2(C_2O_4)_3.\underline{x}H_2O$	712§	713§	716§	719.9§
	OXIDE, Pr_6O_{11}	722	723	726	729.9
	CARBONATE, $Pr_2(CO_3)_3.0\text{-}1H_2O$	*	*	736¶	739.9¶
	CHLORIDE, $PrCl_3.\underline{x}H_2O$	*	*	746¶	749.9¶
	NITRATE, $Pr(NO_3)_3.6H_2O$	*	*	756¶	759.9¶
	SULFATE, $Pr_2(SO_4)_3.8H_2O$	*	*	766¶	769.9¶
	FLUORIDE, $PrF_3.0\text{-}2H_2O$	*	*	786¶	789.9¶
Rare Earth Oxide Composition	PRASEODYMIUM OXIDE	85% min.	90% min.	99% min.	99.9% min.
	NEODYMIUM OXIDE	2 to 15%	1 to 7%	1% max.	0.1% max.
	CERIUM OXIDE	2 to 15%	1 to 7%	1% max.	0.1% max.
	OTHER RARE EARTH OXIDES	up to 5%	up to 3%	1% max.	0.1% max.
	TOTAL	100%	100%	100%	100%

*These can be made on request.

¶Small stocks are normally inventoried for research use.

§Oxalates are made as intermediates in the preparation of oxides, and may contain small amounts of residual organic complexing agents used in the ion-exchange separation process.

Praseodymium salts, except the oxide, have a characteristic green color increasing in intensity with praseodymium purity. Praseodymium oxide, Pr_6O_{11}, is black as ordinarily prepared by ignition in air.

These salts are typical. Compounds not listed, and other purities can be made in some cases, and inquiry should be made for more specific information.

For lower purity, less expensive praseodymium salts, see data on "Didymium Salts".

Shipping containers: Small lots in glass or plastic bottles, or polyethylene-lined cans; larger lots in polyethylene-lined fiber drums.

TYPICAL ANALYSES OF PRASEODYMIUM SALTS

The data below are not specifications, but represent typical analyses. Unless indicated, the analyses reported are approximate and are intended only to indicate the nature of these materials. All data are in per cent. For a more complete breakdown of rare earth impurities, see data in the table on "Grades of Praseodymium Salts".

PRASEODYMIUM SALT	CODE	PURITY DESIGNATION	TOTAL RARE EARTH OXIDE	Pr_6O_{11}	Nd_2O_3	CeO_2	OTHER RARE EARTH OXIDES
OXALATE	712	85	50§	40	1-7.5	1-7.5	up to 2.5
	713	90	50§	45	0.5-3.5	0.5-3.5	up to 1.5
	716	99	50§	49.5	Less than 0.5 % total		
	719.9	99.9	50§	50	Less than 0.05% total		
OXIDE	722	85	98-99*	78-79	2-15	2-15	up to 5
	723	90	98-99*	88-89	1-7	1-7	up to 3
	726	99	98-99*	97-98	Less than 1% total		
	729.9	99.9	98-99*	98-99	Less than 0.1% total		
CARBONATE	736	99	70	69.3	Less than 0.7 % total		
	739.9	99.9	70	70	Less than 0.07% total		
CHLORIDE	746	99	45	44.6	Less than 0.5 % total		
	749.9	99.9	45	45	Less than 0.05% total		
NITRATE	756	99	40	39.6	Less than 0.4 % total		
	759.9	99.9	40	40	Less than 0.04% total		
SULFATE	766	99	45	44.6	Less than 0.5 % total		
	769.9	99.9	45	45	Less than 0.05% total		
FLUORIDE	786	99	77	76.2	Less than 0.8 % total		
	789.9	99.9	77	77	Less than 0.08% total		

*Praseodymium oxide is somewhat hygroscopic and absorbs moisture and carbon dioxide from the air. The analyses are for as-packed material. These oxides normally show up to 2% loss on ignition.

§Pricing for commercial quantities is based on total rare earth oxide assay of the oxalate.

TECHNICAL DATA

RARE EARTH SALTS

American Potash & Chemical Corporation TRONA

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Materials described commercially under the name "rare earth" salts are essentially natural mixtures of compounds of the rare earth elements. These materials are not physical mixtures, but are chemical mixtures obtained from the chemical extraction of the rare earths from the ore.

The composition of the rare earth mixture in these materials is very much like that in the ore except that the content of yttrium and yttrium earths is lower. The average atomic weight of the contained rare earth metal is 140.

Since these materials consist largely of the lighter rare earths (cerium, lanthanum, praseodymium, and neodymium), they are often referred to as "cerium earth" mixtures.

Most large-scale applications of rare earths are based on these materials. They are the least expensive rare earth materials, and are available in tonnage quantities. Adequate inventories are maintained to cover most anticipated requirements.

These salts are typical of the rare earth salts we make. Compounds not listed, and other purities can be made in some cases, and inquiry should be made for more specific information.

Shipping containers: Small lots in glass or plastic bottles, or polyethylene-lined cans; larger lots in polyethylene-lined fiber drums or steel drums. Standard containers for rare earth chloride are steel drums containing 500 lb. net.

RARE EARTH SALT	CODE	FORMULA	COLOR AND FORM	SOLUBILITY Water§	Acids
HYDRATE	310	Hydrated RE oxide	Yellow powder	I	S
CARBONATE	320	$RE_2(CO_3)_3.xH_2O$	Fine pink powder	I	S
OXIDE	330	$RE_2O_3 + CeO_2$	Brown powder	I	S
CHLORIDE	340	$RECl_3.6H_2O$	Flakes	VS	S
FLUORIDE	370	$REF_3.0\text{-}1H_2O$	Powder	I	I
OXALATE	381	$RE_2(C_2O_4)_3.xH_2O$	Pink powder	I	SS

APPROXIMATE COMPOSITION OF THE CONTAINED RARE EARTH OXIDE IN THESE MATERIALS

	%		%
Lanthanum oxide, La_2O_3	24	Samarium oxide, Sm_2O_3	3
Cerium oxide, CeO_2	48	Gadolinium oxide, Gd_2O_3	2 (approx.)
Praseodymium oxide, Pr_6O_{11}	5	Yttrium oxide, Y_2O_3	0.2 (approx.)
Neodymium oxide, Nd_2O_3	17	Other rare earth oxides	0.8 (approx.)
			100

§ I = insoluble, SS = slightly soluble, S = soluble, VS = very soluble.

TYPICAL ANALYSES

The data below are not specifications, but represent typical analyses. Unless indicated, the analyses reported are approximate and are intended only to indicate the nature of the material. All data in per cent.

Code Number	310 RARE EARTH HYDRATE	320 RARE EARTH CARBONATE	330 RARE EARTH OXIDE	340 RARE EARTH CHLORIDE	370 RARE EARTH FLUORIDE	381 RARE EARTH OXALATE
CeO_2	37.4	31.2	45.6	22.0	38.4	22.6
La_2O_3	18.7	15.6	22.8	11.0	19.2	11.2
Nd_2O_3	13.3	11.0	16.2	7.8	13.6	8.0
Pr_6O_{11}	3.9	3.3	4.7	2.3	4.0	2.4
Sm_2O_3	2.3	2.0	2.8	1.4	2.4	1.4
Gd_2O_3	1.6	1.3	1.9	1.0	1.6	0.9
Y_2O_3	0.2	0.1	0.2	0.1	0.2	0.1
Other REO	0.6	0.5	0.8	0.4	0.6	0.4
TOTAL REO (min.)	78	65	95	46	80	47
SO_3	1-2	0.5	1-2	0.05	0.05	
P_2O_5	1-2	0.01	0.5	0.05	0.5	
Na_2O	1	0.05	0.1	0.5	0.5	
CaO + MgO	2-3	0.2	1	2	2	
Fe_2O_3				0.005		
$Fe_2O_3 + Al_2O_3$	3-4	0.1	1-2	0.1	1	
SiO_2	0.1	0.05	0.05	0.02	0.2	
Fluoride (min.)	-	-	-	-	26	
Acid insol.	0.2	nil	0.2	0.5	-	
Water insol.	-	-	-	0.5-1	-	
Moisture (105°C)	0-3	0-5	nil	-	nil	
(105-200°C)	5	-	nil	-	nil	
LOI* ("as-is")	11-16	30-35	0-1	-	-	53
Valence of cerium	4	3	4	3	3	3

*LOI = loss on ignition REO = rare earth oxide

R-1-664ex

TECHNICAL DATA

THORIUM NITRATE

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

THORIUM NITRATE CODE 100

THORIUM NITRATE CODE 101

THORIUM NITRATE CODE 102

THORIUM NITRATE CODE 103

THORIUM NITRATE CODE 104

Thorium nitrate is a colorless crystalline solid with the approximate composition $Th(NO_3)_4.4H_2O$. Codes 100 and 102 are made in the form of lumps. All other codes are in the form of small crystals.

Codes 102, 103, and 104 will pass the specifications for reagent grade thorium nitrate.*

Code 104 is produced only in experimental quantities. Inquiries for larger-than-experimental amounts are welcomed.

Shipping containers: Small lots in glass bottles; larger lots in polyethylene-lined fiber drums. Standard drum sizes are 120 lb and 200 lb.

TYPICAL ANALYSES

(All values in parts per million unless otherwise stated. These are not specifications, and are intended only to indicate typical analyses.)

	Code 100	Code 101	Code 102	Code 103	Code 104
ThO_2	47%	46%	47%	46%	46%
Rare Earth Oxide	25	25	25	15	2
Sulfate, SO_3	6000**	100	200	100	50
Chloride, Cl	100	20		10	10
Phosphate, P_2O_5	25	25	25	25	1
Iron, Fe	50	30	50	1	1
Calcium oxide, CaO	100	100	100	10	10
Magnesium oxide, MgO	200	200	200	100	100
Alkalis, Na + K + Li				500	500
Alkali salts*	1000	1000	1000	1000	
Aluminum, Al*	pass test*	pass test*	pass test*	pass test*	pass test*
Heavy metals*			pass test*	pass test*	pass test*
Titanium*	pass test*	pass test*	pass test*	pass test*	pass test*
Water solubility*	pass test*	pass test*	pass test*	pass test*	pass test*
Silica, SiO_2	100	100	100	50	50
Uranium, U	1-50	1-50	1-50		10
Boron, B	1	1	1	0.5	0.5
Rare Earths:					
Ce	5	5	3	1	ND
Sm	5	5	4	0.5-1	ND
Eu	0.5	0.5	0.4	0.1	0.01
Gd	5	5	4	0.5	0.01
Dy	0.5	0.5	0.4	0.5	0.01

*Rosin, Joseph, "Reagent Chemicals and Standards", Second ed., Van Nostrand, New York, 1956, pp. 455-6.

**Intentionally added for mantle manufacture.

TH-4-466ex

TECHNICAL DATA

THORIUM OXIDE

American Potash & Chemical Corporation TRONA

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

THORIUM OXIDE CODE 112**

THORIUM OXIDE CODE 112 Heavy

THORIUM OXIDE CODE 115**

THORIUM OXIDE CODE 116

THORIUM OXALATE CODE 173

Thorium oxide is a white, refractory powder, insoluble in water, dilute acids, and bases. The specific gravity (pycnometer method) is about 9.5; the melting point is about 3200°C.

Bulk values and particle sizes vary with the type of preparation. See page 2 of this data sheet for more details.

Thorium oxalate is a white powder, insoluble in water and most acids. Soluble in solutions of alkali and ammonium oxalates. Above 300-400°C, it decomposes to thorium oxide.

Shipping containers: Glass bottles containing 1 lb., 5 lb., 10 lb., or 100 lb., and polyethylene-lined fiber drums containing up to 250 lb.

TYPICAL ANALYSES

(All values in parts per million unless otherwise stated. These are not specifications, and are intended only to indicate typical analyses.)

	Code 112 and Code 115**	Code 112 Heavy	Code 116	Code 173
PURITY DESIGNATION	99.9%	99.9%	99.9%	
ThO_2*	99% min.	99% min.	99% min.	57.0%
Rare Earth Oxide	30	30	30	30
Sulfate, SO_3	50			
Phosphate, P_2O_5	10	50		5
Fe	6	5		3
CaO	10	20		20
MgO	10	200		20
Na + K + Li	100	1000		
Silica, SiO_2	50	500		10
Boron, B	0.1	1		
Uranium, U	10			
Loss on Ignition*	5000	5000		
Rare Earths:				
Sm	1-2	1-2		
Eu	0.2	0.2		
Gd	1	1		
Dy	1	1		

*Normal ThO_2 contents are 99% since thorium oxide absorbs up to about 2% moisture and carbon dioxide when allowed to stand in air.

**Codes 112 and 115 are essentially similar except for method of preparation, particle size, and bulk value.

PARTICLE SIZE AND BULK DENSITY OF THORIUM OXIDE

PARTICLE SIZE

The particle size and size distribution of materials having particle sizes greater than 325 mesh (44 microns) may be determined by standard sieve analysis methods. Particle size determinations in the sub-sieve range present more of a problem. Many methods can be used for such measurements, and the choice of method depends somewhat on the way the information is to be used.

The typical results given below have been determined using the sedimentation method (Andreasen pipette and photoextinction), the gas permeability method (Fisher Sub-Sieve Sizer), and photo- and electron-micrography. Details of these methods are given in the literature.*

Particle size and particle size distribution in the sub-sieve range are conveniently expressed in terms of mean particle diameter (d_m) and standard deviation (σ). The mean particle diameter is that diameter corresponding to a sphere having the same sedimentation rate, surface area, etc. as the particle being measured. The standard deviation is a measure of the variance of the measured values from some average value. For many materials, the distribution is such that a straight line results when the logarithm of d is plotted against the per cent of particles having a diameter less than d_m on log probability paper. The intercept of the line with the 50 per cent ordinate gives the mean particle diameter. The standard deviation, σ, is calculated from the slope of the line.

Specifically, $\sigma = d_{50}/d_{15.84} = d_{84.16}/d_{50}$. Statistically, for such a distribution, 68 per cent of the particles lie between $d \cdot \sigma$ and d/σ, and 95 per cent lie between $d \cdot \sigma^2$ and d/σ^2. Actually, particle size distribution may deviate somewhat from this behavior due to shape factors, etc.

THORIUM OXIDE CODES 112 and 115 are prepared by calcining thorium oxalate. The particle size and particle size distribution of these oxides depend primarily on the oxalate precipitation conditions and on the ignition temperature.

No special care is normally taken in making Code 112 to obtain a specified particle size or size distribution. These oxides consist of loosely bound aggregates and a typical sieve analysis will show -100 mesh - 99.9%, -200 mesh - 95-97%, -325 mesh - 85-90%. Simple grinding reduces all of these to -325 mesh. The average particle size of the -325 mesh material varies from 10 to 20 microns with a standard deviation of 2 to 2.5.

Again, these -325 mesh particles consist largely of agglomerates which may be furthur reduced in size on milling.

THORIUM OXIDE CODE 115 is prepared under controlled conditions which give an oxide having a mean volume diameter (measured by sedimentation) of 2 to 4 microns and a standard deviation of about 1.5.

THORIUM OXIDE CODE 112 HEAVY is made by direct ignition of thorium nitrate and is characterized by a very wide particle size distribution. As normally made, about 90 per cent is -325 mesh, and about 1 per cent is +200 mesh.

THORIUM OXIDE CODE 116 is made by a process that gives particles with sizes generally above 325 mesh. Some control can be exercised in manufacture to give particle sizes or agglomerate sizes in the sieve-size range. Further details are available on request.

BULK DENSITY

For a given material, bulk density is a function of particle size distribution. Materials with a wide size distribution generally pack more efficiently and therefore have a greater bulk density.

Poured bulk density is determined by pouring a 100 g. sample through a funnel with a 0.25 inch ID stem into a 100 ml. graduated cylinder.

Tapped bulk density is determined by measuring the volume of a 100 g. sample in a 100 ml. graduated cylinder after tapping on a mechanical tapper to constant volume for 30 minutes.

The Table below lists typical particle size and bulk value data for thorium oxides. These data illustrate the ranges of information obtainable by different methods. In using these data, the way the information is to be used should determine the method of measurement.

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*Cadle, R.D., "Particle Size Determination", Interscience Publishers, New York, 1955.
Dalla Valle, J.M., "Micromeritics", Second ed., Pittman, New York, 1948.
Orr, C., and Dalla Valle, J.M., "Fine Particle Measurement", Macmillan, New York, 1959.

THORIUM OXIDE CODE	Particle Size			Bulk Density g/cm³	
	By Fisher Sub-Sieve Sizer (microns)	By Sedimentation (microns)	σ	Poured	Tapped
112	1-4	5-15	2-2.5	1.6-2.3	2.5-3.2
112 Heavy	4-10	-	-	4-4.5	4.5-5
115	0.6-0.8	2-4	1.5	1-1.2	1.5-2
116	-	-	-	4-4.5	4.5-5

TECHNICAL DATA

American Potash & Chemical Corporation
RARE EARTH DIVISION
258 ANN STREET, WEST CHICAGO, ILLINOIS
TRONA

GRANULAR THORIUM OXIDE Code 116

Thorium Oxide Code 116 is a free flowing granular product having particles largely in the 100 to 325 mesh range. It varies from colorless to light tan and has the appearance of fine sand. Under the microscope it appears as transparent to translucent particles having sharp, but non-regular edges. It is prepared by a special technique which yields hard, high density particles.

This is in contrast to regular thorium oxide powders which consist of loosely bound aggregates one to twenty microns in diameter. The bulk density of Code 116 is in the range of 4 to 4.5 g/cm^3 which is approximately twice that of other grades.

Physical Properties. Code 116 Thorium Oxide is compared below with conventional thorium oxides:

	Code 116	Conventional Thorium Oxide*
Poured bulk density	4 to 4.5 g/cm^3	1.6 to 2.3 g/cm^3
Tapped bulk density	4.5 to 5 g/cm^3	2.5 to 3.2 g/cm^3
Screen analysis, mesh		
+100	13%	0.1%
-100+140	12%	3 to 5%
-140+200	30%	
-200+325	35%	5 to 12%
-325	10%	85 to 90%
	100%	100%

*Such as Codes 111 and 112.

Note on screen analysis distribution: The numbers given are representative and are not a specification. Individual lots will vary somewhat from these values. Although the yield in the mesh ranges given can be controlled to some extent, the maximum yield in any range will not generally exceed 40%.

Chemical Properties and Purity. As normally prepared, Thorium Oxide Code 116 will correspond in purity to that of Thorium Oxide Code 112 described in the Technical Data Sheet for "Thorium Oxide". Code 116 material can also be made in purities comparable to the other grades, represented by Codes 111 and 113. The normal thorium oxide (ThO_2) content of Code 116 material is 99% minimum, and the nominal rare earth content is 30 ppm.

Suggested Applications.

(1) Ceramic fabrication where dense material with large particle size is desirable.

(2) Free flowing powder for flame spraying.

(3) Nuclear fuel elements: as a retainer in reprocessing thorium oxide, and in the fabrication of swaged fuel elements.

(4) Applications where dusting of thorium oxide must be minimized.

(5) Sintered thorium oxide infrared transmitting windows.

(6) Thoria cathodes and cathode coatings in electronic tubes where the higher bulk density of Code 116 material would be desirable.

PHOTOMICROGRAPH BY REFLECTED LIGHT

of

THORIUM OXIDE Code 116 (100X)

TECHNICAL DATA

YTTRIUM SALTS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Standard grades of yttrium oxides are described below. These are separated from rare earth ores and concentrates by ion exchange techniques.

Purity designations refer to the content of yttrium oxide in the total contained rare earth oxide + yttrium oxide and do not take into account non-rare earth impurities. They are based on the best available spectrographic and spectrophotometric analyses of product and impurity material balance.

TYPICAL ANALYSES OF YTTRIUM OXIDE

CODE NUMBER	1115	1116	1117	1118
PURITY DESIGNATION	99.9%	99.99%	99.999%	99.9999%
La_2O_3, CeO_2, Pr_6O_{11}, Nd_2O_3, Sm_2O_3	nil to traces	nil to traces	not detectable	not detectable
Eu_2O_3, Gd_2O_3, Tb_4O_7, Dy_2O_3	0.1 max.	0.01 max.	0.001 max.	0.0001 max.
Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, Lu_2O_3	nil to traces	nil to traces	not detectable	not detectable
Y_2O_3	99.9 min.	99.99 min.	99.999 min.	99.9999 min.

Most rare earth impurities are gadolinium, terbium, and dysprosium, since they tend to concentrate with yttrium in the ion exchange process. Non-rare earth impurities are generally calcium, magnesium, and silicon. They are usually present at about 0.002% or less. Moisture and carbon dioxide can be picked up from the atmosphere. If left exposed this pick-up could amount to as much as 0.5%.

Yttrium oxide Code 1117 is produced from yttrium oxide Code 1116 by subjecting the latter to additional ion exchange purification cycles. Since the Code 1116 starting material contains rare earth impurities below limits of direct spectrographic detection, the Code 1117 material produced from it will be of better quality. Since rare earth impurities cannot be detected in either the Code 1117 material or the Code 1116 starting material, this yttrium oxide is sold without guarantee as to purity, except that we can state that it is better than 99.99% pure.

Yttrium oxide Code 1118 is prepared from yttrium oxide Code 1116 by subjecting the latter to several additional ion exchange purification cycles. Conditions of purification are such that the head and tail fractions containing the rare earth impurities are concentrated to a state where the impurities reach determinable levels and can be measured quantitatively. Ion exchange repurification is continued with close control based on the history of the lot being processed, until the Code 1118 product contains less than 1 ppm total rare earths.

Other compounds such as the common salts, acetates, carbonates, oxalates, chlorides, nitrates, sulfates, etc. are available usually from stock. Unusual compounds will be undertaken by our Special Products Department. Please inquire for further information.

We hesitate to produce salts of Code 1117 and 1118 purities, because of the likelihood of contamination during preparation of the salt.

American Potash & Chemical Corporation

TRONA

RARE EARTH DIVISION

WEST CHICAGO, ILLINOIS

PRICE SCHEDULE

FEBRUARY 1, 1966

PRODUCTION CHEMICALS

This price list applies to small quantities of rare earth, yttrium, and thorium chemicals. Quotations on larger amounts and on other salts not listed will be supplied on request. Lower prices apply in most cases for commercial quantities.

PACKAGING:

The smallest package size available is listed for each item. For most items, standard package sizes are listed. In most cases, glass bottles or polyethylene-lined drums, depending on quantity -- seller's option.

TERMS:

Terms are net 30 days to those with acceptable credit standing, f. o. b. West Chicago, Illinois. MINIMUM ORDER IS ONE POUND.

THORIUM MATERIALS:

To acquire thorium salts, a purchaser, except as noted below, must obtain a license from the U. S. Atomic Energy Commission, Washington 25, D. C., Attention of Director, Division of Licensing and Regulation, on Form AEC-2, "Application for Source Material License". For details of the licensing regulations, consult 10 CFR Part 40, "Source Material", published in the Federal Register, Vol. 26, No. 9, Jan. 14, 1961. The license number must appear on your purchase order.

Domestic users in the following categories are exempt from licensing if they purchase no more than 15 pounds of contained thorium at any one time, and if they receive not more than 150 pounds of contained source material (thorium plus uranium) in any one year:

1. Pharmacists using source material solely for the compounding of medicinals;
2. Physicians using source material for medicinal purposes;
3. Persons receiving possession of source material from pharmacists and physicians in the form of medicinals or drugs; and
4. Commercial and industrial firms, and research, educational and medical institutions for research, development, educational or commercial purposes.

Thorium materials cannot be shipped by Air Parcel Post or Parcel Post.

THESE PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE, AVAILABILITY OF MATERIAL, AND GOVERNMENTAL REGULATIONS.

PRODUCTION CHEMICALS
PRICE SCHEDULE

FEBRUARY 1, 1966

CODE		Price Per Lb. 1-49 Lbs.	50-99 Lbs.
100	Thorium Nitrate	$ 4.60	$ 3.80
101	ditto	5.05	4.20
102	ditto	5.85	4.85
103	ditto	6.30	5.25
104	ditto	7.20	6.00
112	Thorium Oxide	12.30	10.25
112H	ditto	12.30	10.25
115	ditto	12.30	10.25
116	ditto	24.00	20.00
173	Thorium Oxalate	7.20	6.00
200	Ceric Hydrate	2.10	1.75
201	ditto	2.50	2.00
210	Ceric Oxide	2.30	1.90
227	Cerous Oxalate	4.95	4.12
237	Cerous Chloride	5.85	4.85
277	Cerous Nitrate	4.50	3.75
280	Ceric Ammonium Nitrate	2.70	2.25
310	Rare Earth Hydrate	1.30	1.10
330	Rare Earth Oxide	2.70	2.25
340	Rare Earth Chloride	0.70	0.55
350	Rare Earth Nitrate	1.45	1.20
370	Rare Earth Fluoride	1.85	1.55
381	Rare Earth Oxalate	2.35	1.95
400	Didymium Chloride	0.70	0.55
411	Didymium Carbonate	1.60	1.30
420	Didymium Oxide	2.25	1.95
440	Didymium Hydrate	2.25	1.90
480	Didymium Fluoride	1.85	1.55
613	Neodymium Oxalate, 85%	2.50	2.10
621	Neodymium Oxide, 65%-70%	4.00	3.45
622	ditto 65%-70%	5.00	4.10
623	ditto 85%	5.40	4.50
631	Neodymium Carbonate, 65%-70%	2.25	2.00

266ex

TECHNICAL DATA

HIGH PURITY SALTS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

High purity rare earths are separated from rare earth mixtures by ion exchange, with the exception of lanthanum and cerium. The basic principles of ion exchange are described in the literature.* Extraordinary care is taken to reduce rare earth impurities to extremely low levels. Non-rare earth impurities are kept to the lowest possible levels by use of proper equipment and highly purified reagents.

Purity designations 99%, 99.9%, etc., refer to the minimum content of the major rare earth in the total rare earths present and do not take into account non-rare earth impurities. They are based on best available spectrographic and spectrophotometric analyses of product and impurity material balance, and on careful control of preparation conditions.

Limits of detection for rare earth impurities are given in Table 1.

Non-rare earth impurities, in some cases, are now more difficult to separate from the rare earths than are the rare earths themselves. This is a tribute to the advanced state of the science and art of rare earth separation, inconceivable a few years ago. Major detectable impurities, aside from normal atmospheric moisture and carbon dioxide pick-up, are silicon, calcium, and magnesium.

Other compounds such as the common salts, acetates, carbonates, oxalates, chlorides, nitrates, sulfates, etc., are available usually from stock. Unusual compounds will be undertaken by our Special Products Department. Inquire for further information.

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*Powell, J., and Spedding, F. H., "Basic Principles Involved in the Macro-Separation of Adjacent Rare Earths from Each Other by Means of Ion Exchange", publication of U.S. Atomic Energy Commission, ISC-617 (Oct. 26, 1955).

Table 1

LIMITS OF DETECTION

PPM of Rare Earth Impurities

Matrix	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Y		20	100	50	50	50	20	50	500	42	50	10	10	13	20
La	10		110	50	50	10	10	20	200	20	10	14	10	10	50
Ce		180		10	100										
Pr		39	300		300	78									
Nd				500		100	100								
Sm	100		500		120		110	210							
Eu	50	20	500	500	20	100		30	500	50	10	50	20	10	20
Gd	100	20				50	50		200						
Tb	175					20	20	400		280					
Dy	40	50	200		100	50	50	200	1000		200	50	100	10	20
Ho	20									93		50			
Er	65										170		45	15	
Tm	31	20	200	200	140	100	15	40		210	260	26		150	265
Yb			100	50	200		20	20		50		100	40		100
Lu												10	23	20	

American Potash & Chemical Corporation

RARE EARTH DIVISION

WEST CHICAGO, ILLINOIS

TRONA

PRICE SCHEDULE

JANUARY 1, 1967

HIGH PURITY RARE EARTH & YTTRIUM SALTS

This price list applies to research quantities of high purity rare earth and yttrium salts.

PACKAGING:

The smallest package size available is listed for each item. For most items, standard package sizes are listed.

Please inquire for additional information. Prices for larger quantities on request.

TERMS:

Terms are net 30 days to those with acceptable credit standing, f. o. b. West Chicago, Illinois.

RARE EARTH SALTS:

Acetates, carbonates, chlorides, fluorides, nitrates, oxalates, sulfates and other common salts are available at the same price as the corresponding oxide purity with the exception of cerium and lanthanum salts.

The price of materials in less than one pound quantities will be determined by the price corresponding to the amount of material packaged individually.

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE, AVAILABILITY OF MATERIAL, AND GOVERNMENTAL REGULATIONS.

HIGH PURITY RARE EARTH & YTTRIUM SALTS
RESEARCH QUANTITY PRICE SCHEDULE

OXIDE		CODE	Min. Pkg. Gms.	Per Gm. 1 to 99 Gms.	Per Gm. 100 Gm. Pkg.	Per Lb. 1 Lb. Pkg.	Per Lb. 2-99 Lb. Pkg.	Per Lb. 100 Lbs. Or More
Lanthanum ..	99.9%	525	10	$ 0.05	$ 0.04	$ 9.50	$ 7.80	$ 6.00
ditto	99.99%	528	10	0.05	0.04	10.80	9.00	6.50
ditto	99.997%	529	10	0.15	0.13	35.00	30.00	27.00
ditto	99.999%	529.9	5	0.80	0.65	225.00	185.00	-----
Ceric	99.9%	217	10	0.05	0.04	9.00	7.50	5.00
ditto	99.99%	217.91	5	0.75	0.60	200.00	185.00	-----
ditto	99.999%	217.92	5	0.80	0.65	225.00	200.00	-----
ditto	99.9999%	217.93	5	0.95	0.80	295.00	-----	-----
Neodymium .	99%	629	10	0.15	0.13	35.00	32.50	26.00
ditto	99.9%	629.9	10	0.20	0.15	40.00	37.50	30.00
ditto	99.999%	629.92	5	0.95	0.80	295.00	285.00	-----
Praseodymium	99%	726	10	0.20	0.15	40.00	37.50	27.85
ditto	99.9%	729.9	10	0.25	0.20	50.00	45.00	40.95
ditto	99.999%	729.92	5	1.00	0.85	350.00	330.00	-----
Samarium ..	99%	822	10	0.25	0.20	50.00	40.00	38.00
ditto	99.9%	823	10	0.30	0.25	60.00	50.00	45.00
ditto	99.99%	823.91	5	0.65	0.45	125.00	110.00	-----
Europium ...	99.9%	1013	1	3.25	2.00	900.00	850.00	-----
ditto	99.99%	1014	1	5.50	3.50	1350.00	1350.00	-----
ditto	99.999%	1014.92	1	7.50	5.00	2000.00	2000.00	-----
Gadolinium .	99%	928.9	5	0.40	0.30	90.00	85.00	80.00
ditto	99.9%	929.9	5	0.45	0.35	100.00	95.00	90.00
ditto	99.99%	929.91	5	1.95	1.30	375.00	300.00	300.00
ditto	99.999%	929.92	5	2.50	1.50	500.00	500.00	-----
Terbium	99.9%	1805	1	2.50	2.10	925.00	925.00	925.00
ditto	99.999%	1805.92	1	5.00	3.50	1400.00	1400.00	-----
Dysprosium .	99.9%	1705	5	0.65	0.43	125.00	100.00	75.00
ditto	99.99%	1705.91	5	2.50	2.10	925.00	925.00	-----
Erbium	99.9%	1305	5	0.70	0.50	175.00	150.00	125.00

HIGH PURITY RARE EARTH & YTTRIUM SALTS
RESEARCH QUANTITY PRICE SCHEDULE

OXIDE		CODE	Min. Pkg. Gms.	Per Gm. 1 to 99 Gms.	Per Gm. 100 Gm. Pkg.	Per Lb. 1 Lb. Pkg.	Per Lb. 2-99 Lb. Pkg.	Per Lb. 100 Lbs. Or More
Yttrium	99.9%	1115	10	$ 0.30	$ 0.20	$ 65.00	$ 55.00	$ 49.00
ditto	99.99%	1116	10	0.35	0.25	75.00	65.00	57.00
ditto	99.999%	1117	10	1.50	1.00	350.00	330.00	330.00
ditto	99.9999%	1118	10	2.50	1.50	500.00	500.00	500.00
Holmium ...	99.9%	1605	5	0.75	0.55	220.00	210.00	200.00
Ytterbium ..	99.9%	1202	5	1.25	1.00	300.00	285.00	275.00
Thulium	99.9%	1405	1	5.50	5.00	2000.00	2000.00	2000.00
Lutetium ...	99.9%	1505	1	9.00	8.00	3500.00	3500.00	3500.00
ditto	99.999%	1505.92	1	11.90	10.95	4975.00	4975.00	-----

TECHNICAL DATA

METALS

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

Rare earth and yttrium metals are available in regular grades in the form of ingots, lumps, and turnings. Yttrium metal is also available in metallurgical, low-oxygen, and crystal sponge grades. Thorium metal is supplied only in the form of powder.

Rare earth and yttrium metals in regular grades are normally prepared as ingots approximately one inch in diameter weighing about one pound each. Turnings are obtained from these ingots. Pieces or lumps less than one pound in weight are obtained from inventoried ingots either by sawing or turning.

Prices actually charged for ingots or lumps are based on the weight of the material shipped. Although every effort will be made to ship pieces having weights as close as possible to those ordered, some variation in weight is normal and can be expected.

Rare earth and yttrium metals are usually compacted by induction melting in vacuum or in an inert atmosphere and casting in copper, tantalum, or molybdenum molds. The choice of mold material is variable and depends on the metal and specific technique used. In most cases, the solubilities of these mold materials in the metals are small, and for most uses these impurities do not interfere.

Most of the rare earth metals are reasonably stable toward atmospheric corrosion. Lanthanum, and to some extent praseodymium and neodymium, are slowly oxidized in air. Europium oxidizes very easily in air. Some of the metal turnings, particularly those of lanthanum and europium, may actually burn spontaneously in air, especially if subject to abrasion in handling. Due to the extreme ease of oxidation of europium, this metal is not supplied in the form of turnings.

Lumps and ingots, including europium metal, are normally shipped in a stripable protective plastic coating to eliminate atmospheric corrosion and to maintain the appearance of the product. Storage and shipment of ingots and pieces of these metals in stripable plastic coatings has been found to be more satisfactory than shipment under oil or inert gases such as argon. Even europium metal which oxidizes rapidly in air can be best shipped in the plastic coating rather than under oil or inert atmosphere. Turnings are normally packaged in glass bottles or tin cans; the more active metal turnings may be shipped under light mineral oil. Where unusual packing is required, details of the packing will be supplied with the package.

Subject to unusual demand, these metals are available from inventory maintained from production on a research scale.

YTTRIUM METAL GRADES. Regular grade yttrium metal is available in the form of ingots or turnings as described for rare earth metals. Metallurgical grade is an 80% yttrium-20% rare earth alloy described in the table below. Low-oxygen grade yttrium metal is available normally as sponge-like masses of well defined crystals; the crystals are normally variable in size up to a maximum diameter of about 3 to 4 mm.

TYPICAL MAXIMUM RARE EARTH IMPURITIES IN REGULAR GRADE RARE EARTH AND YTTRIUM METALS

Atomic Number	Regular Grade Metal	Purity Designation	% Rare Earth Maximum Impurities
57	Lanthanum	99.9	0.01 Pr, 0.001 Ce
58	Cerium	99.9	Less than 0.1 (largely La + Pr + Nd)
59	Praseodymium	99.9	0.1 Ce + Nd
60	Neodymium	99.9	0.1 (largely Pr + Sm)
62	Samarium	99.9	0.1 (largely Nd + Gd + Eu)
63	Europium	99.9	0.1 (largely Sm + Gd + Nd)
64	Gadolinium	99.9	0.1 Sm + Eu + trace Tb
65	Terbium	99.9	0.1 Gd + Dy + Y
66	Dysprosium	99.9	0.1 Ho + Y + traces of others
67	Holmium	99.9	0.1 Er + Dy + traces of others
68	Erbium	99.9	0.1 Ho + Tm
69	Thulium	99.9	0.1 Er + Yb + trace Lu
70	Ytterbium	99.9	0.1 Tm + trace Lu + Er
71	Lutetium	99.9	0.1 Yb + Tm + traces of others
39	Yttrium	99.9	0.1 Dy + Gd + traces Tb

TYPICAL NON-RARE EARTH IMPURITIES IN REGULAR GRADE RARE EARTH AND YTTRIUM METALS

Ca - generally less than 0.1% but may reach 0.2-0.3% for thulium and lutetium

Mg - less than 0.1%

Fe - less than 0.1%

Ta - less than 1% except for lutetium where the Ta content is about 2 to 3%

Mo - up to several per cent depending on the rare earth metal; usual range is 0.01-1.5%

O - up to about 0.5% depending on the rare earth metal

N - about 0.002 to 0.1% depending on the rare earth metal

C - less than 0.02%

TYPICAL NON-RARE EARTH IMPURITIES IN LOW-OXYGEN AND CRYSTAL SPONGE YTTRIUM METAL

Oxygen - 0.07%
Nitrogen - 0.005%
Mo - 0.001%
C - 0.015%
HCl insol. - 0.007%

TYPICAL ANALYSES OF METALLURGICAL GRADE YTTRIUM METAL

Yttrium 80%	Y approximately 80%, other rare earths approximately 20%. Non-rare earth impurities somewhat higher than those for pure rare earth metals; the oxygen content will be on the order of several per cent.

TYPICAL ANALYSIS OF THORIUM POWDER

Ca - 0.05%
Fe - 0.1%
Al - 0.02%

Rare Earths - 0.01-0.03%
Th - 97-99%

Particle size: +48 mesh - 6%
-200 mesh - 84%

Analyses of metals shipped can be supplied on request. More detailed specific information on analyses of metals in stock can also be supplied.

American Potash & Chemical Corporation

TRONA

RARE EARTH DIVISION

WEST CHICAGO, ILLINOIS

PRICE SCHEDULE

JULY 1966

RARE EARTH, YTTRIUM AND THORIUM METALS

Prices are for ingots, lumps, and in some cases, crystal sponge and turnings. Thorium is available only in powder form. Ingots or lumps are cut to order and will be supplied in sizes and shapes at our option unless otherwise specified; delivered weights will be as close as possible to buyer's requirements. If delivered piece is over the ordered weight, the invoice will not exceed ordered weight, and if the piece is less than ordered weight, the invoice will be adjusted accordingly.

PURITIES

Unless specified, purities are 99.9% with respect to content of other rare earths in total rare earths present and do not refer to non-rare earth impurities. Thorium metal is 97% to 99%.

THORIUM METAL

Applicable U.S. Atomic Energy Commission licensing regulations apply, and your license number may be required on your order.

SHIPPING REGULATIONS

No special shipping, marking, packaging or labeling requirements are necessary for metal ingot and lumps which are not packaged under oil. Metal turnings and crystal sponge metals are classed as "Flammable Solids NOS", yellow ICC label required, and may not be shipped by mail. Thorium metal powder requires special packaging and will carry a radioactive material label, a yellow ICC label, and may not be shipped by mail.

TURNINGS

Turnings of rare earth and yttrium metal are available, except for europium, lanthanum, cerium, praseodymium, and neodymium. Due to the reactive nature of some of the metals, oxygen contamination may occur on preparing turnings.

MINIMUM ORDER

Minimum order for each metal is stated on price schedule. Less-than-minimum orders will be invoiced at the minimum package quantity.

PACKAGING

Turnings are packed under light mineral oil. Ingots and lumps may be packed in a strippable plastic film.

TERMS

Terms are net 30 days to those with acceptable credit standing, f.o.b. West Chicago.

FORMS

Forms are as indicated: CS = Crystal Sponge I, T = Ingot, Lump or Turnings
I = Ingot or Lumps P = Powder

METAL	FORM	Min. Pkg. Gms.	Per Gm. 10-99 Gms.	Per Gm. 100-450 Gms.	Per Lb. 1-25 Lbs.
Lanthanum	I	10	$ 0.65	$ 0.50	$ 180.00
Cerium	I	10	0.65	0.50	180.00
Praseodymium	I	10	0.80	0.65	225.00
Neodymium	I	10	0.80	0.65	225.00
Samarium	I	10	0.90	0.75	260.00
Europium	I	5	15.00	-	-
Gadolinium	I, T	10	1.35	1.05	350.00
Terbium	I, T	5	8.65	5.70	2000.00
Dysprosium	I, T	10	1.30	1.00	350.00
Holmium	I, T	10	1.75	1.40	500.00
Erbium	I, T	10	1.60	1.25	450.00
Thulium*	I, T	5	18.90	13.50	6000.00
Ytterbium	I, T	10	2.50	1.75	650.00
Lutetium*	I, T	5	25.65	17.70	8000.00
Yttrium					
Low Oxygen	I	10	1.35	1.05	375.00
ditto	CS	10	1.25	1.00	335.00
Standard	I, T	10	1.00	0.80	280.00
ditto	CS	10	0.95	0.80	260.00
80%	I	10	0.80	0.55	160.00
Thorium	P	20	0.25	0.20	65.00

*Availability limited in pound lots and over. Inquire for additional information.

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TECHNICAL DATA

ANHYDROUS CHLORIDES

American Potash & Chemical Corporation TRONA®

RARE EARTH DIVISION · WEST CHICAGO, ILLINOIS

High purity anhydrous chlorides of the rare earths and yttrium are inconvenient to make in research quantities without proper facilities. American Potash & Chemical Corporation offers these materials in small lots as a service and convenience to R/D and small-scale users. Larger quantities can be prepared on request.

Description. These anhydrous chlorides are free-flowing powders and granules. They are hygroscopic, absorbing water easily from the air to form hydrates. They are very soluble in water, giving a clear, slightly acid solution, and are also soluble in alcohols and some other polar organic compounds.

Rare earth and yttrium chlorides have the formula RCl_3.

These anhydrous chlorides may be distilled in high vacuum (100 microns) at 900°-1000°C in Vycor, quartz, or nickel vessels to remove traces of nonvolatile oxychlorides.

Grades. Standard inventory consists of rare earth and yttrium chlorides of 99.9% purity designation, this purity expressed as the content of principal rare earth in the total rare earths and yttrium present. Other grades of anhydrous chlorides can be supplied on special order.

Analysis. The standard chlorides are prepared from high purity oxides containing less than 0.1% rare earth impurities. Total content of Ca, Mg, Si, Fe, and other common impurities will not exceed 0.1% in the chlorides. Oxygen content of the anhydrous chlorides is not determined due to difficulties and uncertainties in analysis. Oxychlorides and oxides, if present, are nonvolatile in vacuum. Nonvolatile residue after sublimation of the chlorides in vacuum will not exceed 1.0%.

Code Numbers, Metal Contents, etc. for standard anhydrous chlorides are given in the table.

Packaging. Standard containers are glass bottles with airtight plastic caps fitted with special polyethylene inserts to exclude air. Consult price list for container size details.

Hydrated chlorides are available as standard products; consult technical data sheets for the individual rare earth or yttrium salts for details.

ANHYDROUS RARE EARTH AND YTTRIUM CHLORIDES

(Standard 99.9% purity designations.)

Anhydrous Chloride	Code No.	% Rare Earth Content*		Approx. Temp., °C		
		Oxide	Metal	M.P.	B.P.¶	2mm Hg VP¶
Lanthanum chloride anhydrous	538 ANH	66	56	850	1750	1100
Cerous chloride anhydrous	237 ANH	70	57	800	1730	1090
Praseodymium chloride anhydrous	749.9 ANH	67	56	770	1710	1080
Neodymium chloride anhydrous	649.9 ANH	67	57	760	1690	1060
Samarium chloride anhydrous	833 ANH	68	59	678	decompose	1010
Europium chloride anhydrous	1023 ANH	68	59	623	decompose	940
Gadolinium chloride anhydrous	939.9 ANH	69	60	609	1580	980
Terbium chloride anhydrous	1835 ANH	69	59	588	1550	960
Dysprosium chloride anhydrous	1735 ANH	69	60	654	1530	950
Holmium chloride anhydrous	1635 ANH	70	61	718	1510	950
Erbium chloride anhydrous	1335 ANH	70	61	774	1500	950
Thulium chloride anhydrous	1435 ANH	70	61	821	1490	940
Ytterbium chloride anhydrous	1232 ANH	71	62	854	decompose	940
Lutetium chloride anhydrous	1535 ANH	71	63	892	1480	950
Yttrium chloride anhydrous	1135 ANH	58	46	680	1510	950

*Ce as CeO_2, Pr as Pr_6O_{11}, Tb as Tb_4O_7; all others as sesquioxides, R_2O_3. All percentages are approximate.

¶From "The Rare Earths", ed. by F.H.Spedding and A.H.Daane, John Wiley & Sons, Inc., New York (1961). Sm, Eu, and Yb trichlorides presumably decompose to the dichlorides (boiling points: $SmCl_2$ - 2030, $EuCl_2$ - 2030, $YbCl_2$ - 1930). 2 mm Hg VP = estimated temperature to give a pressure of 2 mm Hg.

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American Potash & Chemical Corporation

TRONA

RARE EARTH DIVISION

WEST CHICAGO, ILLINOIS

PRICE SCHEDULE

FEBRUARY 1, 1965

ANHYDROUS RARE EARTH AND YTTRIUM CHLORIDES

(Standard 99.9% Purity Designation)

This list applies to research quantities of anhydrous chlorides. Quotations on larger quantities will be supplied on request.

PACKAGING: Packaged sizes are standard, and repackaging is impractical due to the hygroscopic nature of the materials. To avoid repackaging, at our option a lot may consist of more than one package.

TERMS: Net 30 days to those with acceptable credit standing, f. o. b. West Chicago.

Where no prices are shown, materials are not available in these package sizes. Orders for 100, 500, and 1000 to 5000 gram lots may be packaged in 50, 100, 500 and/or 1000 gram packages at our option.

		Price Per Gram				Price Per Lb.	
CHLORIDE	CODE	5 Gms.	25 Gms.	50 Gms.	100 Gms.	1 Lb.	2-99 Lbs. Lots
Lanthanum	538ANH	$ ----	$ .15	$ .12	$ .10	$ 30.00	$ 27.00
Cerous	237ANH	----	.10	.08	.07	25.00	22.00
Praseodymium	749.9ANH	----	.30	.25	.20	59.00	55.00
Neodymium	649.9ANH	----	.25	.20	.15	55.00	50.00
Samarium	833ANH	----	.30	.25	.20	65.00	60.00
Europium	1023ANH	4.00	3.50	3.00	2.50	850.00	800.00
Gadolinium	939.9ANH	----	.65	.50	.35	87.00	80.00
Terbium	1835ANH	4.50	4.00	3.35	2.75	925.00	925.00
Dysprosium	1735ANH	----	.50	.45	.40	100.00	95.00
Holmium	1635ANH	----	.80	.70	.60	165.00	140.00
Erbium	1335ANH	----	.75	.65	.55	150.00	120.00
Thulium	1435ANH	8.00	7.50	7.00	6.00	2000.00	2000.00
Ytterbium	1232ANH	----	1.00	.85	.75	200.00	190.00
Lutetium	1535ANH	11.00	10.00	9.00	8.50	3450.00	3450.00
Yttrium	1135ANH	----	.35	.30	.25	73.00	65.00
Rare Earth	340ANH	----	.06	.06	.06	17.00	12.00
Didymium	400ANH	----	.06	.06	.06	17.00	12.00

THESE PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE, AVAILABILITY OF MATERIAL, AND GOVERNMENTAL REGULATIONS.

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TECHNICAL DATA

ANHYDROUS HIGH PURITY RARE EARTH, YTTRIUM, and THORIUM FLUORIDES

American Potash & Chemical Corporation
RARE EARTH DIVISION
258 ANN STREET, WEST CHICAGO, ILLINOIS

TRONA

High purity anhydrous fluorides of the rare earths and yttrium are inconvenient and expensive to make in research quantities without proper facilities. American Potash & Chemical Corporation offers these chemicals in small lots as a service and a convenience to R/D and small-scale users. Larger quantities can be prepared on request.

DESCRIPTION

The anhydrous fluorides are free-flowing powders and granules. They will not dissolve in water, acid solutions or organic solvents. They will absorb water from the air to form hydrates.

The anhydrous fluorides have the formula RF_3.

GRADES

Standard inventory consists of rare earth and yttrium fluorides of 99.9% purity designation. This purity is expressed as the content of the principal rare earth in the total rare earths present. Other grades of anhydrous fluorides can be supplied on special order.

ANALYSIS

The standard fluorides are prepared from this purity oxides containing less than 0.1% rare earth impurities. The total content of Ca, Mg, Si, Fe, and other common impurities will not exceed 0.1% in the fluorides. Oxygen content of the anhydrous fluorides, by analysis, is less than 0.06% (equivalent to 0.07% H_2O -- assuming the oxygen to be present as H_2O). This is the only available means of establishing the water content.

Anhydrous High Purity Rare Earth, Yttrium, and Thorium Fluorides

Fluoride	Code	% Rare Earth Content		Melting Point, °C*	Density g/cu cm*
		Metal	Fluorides		
Yttrium	1155ANH	60.94	39.06	1152	5.069
Lanthanum	588ANH	70.91	29.09	1493	5.936
Lanthanum	589ANH	70.91	29.09	1493	5.936
Cerium	247ANH	71.09	28.91	1430	-----
Praseodymium	789.9ANH	71.20	28.80	1395	-----
Neodymium	689.9ANH	71.68	28.32	1374	6.506
Samarium	863ANH	72.51	27.49	1306	6.643
Europium	1053ANH	72.73	27.27	1276	6.793
Gadolinium	969.9ANH	73.40	26.60	1231	7.047
Terbium	1855ANH	73.63	26.37	1172	7.236
Dysprosium	1755ANH	74.03	25.97	1154	7.465
Holmium	1655ANH	74.32	25.68	1143	7.644
Erbium	1355ANH	74.58	25.42	1140	7.814
Thulium	1455ANH	74.80	25.20	1158	7.971
Ytterbium	1252ANH	75.22	24.78	1157	8.168
Lutetium	1555ANH	75.43	24.57	1182	8.332
Thorium	160ANH	75.32	24.68	----	-----

*From "The Rare Earths", edited by F. H. Spedding and A. H. Daane; John Wiley & Sons, Inc., New York (1961).

American Potash & Chemical Corporation

TRONA

RARE EARTH DIVISION

WEST CHICAGO, ILLINOIS

FEBRUARY 1, 1965

PRICE SCHEDULE

ANHYDROUS RARE EARTH, YTTRIUM AND THORIUM FLUORIDES

(Standard 99.9% Purity Designation)

This list applies to research quantities of anhydrous rare earth fluorides. Quotations on larger amounts will be supplied on request.

PACKAGING: Package sizes are standard, and repackaging is impractical because of the hygroscopic nature of these materials. At our option, a lot may consist of more than one package.

TERMS: Net 30 days to those with acceptable credit standing, f.o.b. West Chicago.

Where no prices are shown, materials are not available in these package sizes. Orders for 100 gram to 1 pound lots may be packaged in 25, 50, or 100 gram packages at our option.

		Price Per Gram				Price
FLUORIDE	CODE	5 Gms.	25 Gms.	50 Gms.	100 Gms.	per Lb.
Lanthanum	588ANH	$ ----	$ .10	$ .08	$ .07	$ 25.00
ditto	589ANH	----	.15	.12	.10	30.00
Cerium	247ANH	----	.10	.08	.07	25.00
Praseodymium	789.9ANH	----	.30	.25	.20	60.00
Neodymium	689.9ANH	----	.25	.20	.15	50.00
Samarium	863ANH	----	.35	.30	.25	70.00
Europium	1053ANH	4.25	3.85	3.25	2.65	900.00
Gadolinium	969.9ANH	.60	.50	.45	.40	110.00
Terbium	1855ANH	4.50	4.00	3.35	2.75	950.00
Dysprosium	1755ANH	.80	.65	.50	.45	125.00
Holmium	1655ANH	1.30	1.10	.95	.85	225.00
Erbium	1355ANH	1.25	1.00	.85	.75	200.00
Thulium	1455ANH	8.00	7.50	7.00	6.00	2000.00
Ytterbium	1252ANH	2.00	1.50	1.25	1.00	325.00
Lutetium	1555ANH	11.50	10.50	9.50	9.00	3575.00
Yttrium	1155ANH	.80	.65	.50	.35	80.00
Thorium	160ANH	----	.45	.30	.27	76.00
Rare Earth	370ANH	----	.05	.05	.05	15.00
Didymium	480ANH	----	.05	.05	.05	15.00

THESE PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE, AVAILABILITY OF MATERIALS, AND GOVERNMENTAL REGULATIONS.

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TECHNICAL DATA

American Potash & Chemical Corporation
RARE EARTH DIVISION
258 ANN STREET, WEST CHICAGO, ILLINOIS
TRONA

TECHNICAL PUBLICATIONS

The Rare Earth Division has published a wealth of technical information that is available at no charge to interested firms and individuals. The following is a list of these bulletins:

TECHNICAL BINDER: A complete description of all of our thorium, rare earth, and yttrium chemicals. Typical analyses and price information are included.

ABSORPTION SPECTRA (R-4-160): Absorption curves of separated rare earths and rare earth mixtures.

CATALYST USES (R-3-1259): A bibliography of the technical literature where rare earth materials have been used as catalysts and as catalyst promoters and activators.

CERIUM OXIDE (C-3-760): A comprehensive study of various cerium compounds -- properties, uses, and chemistry.

DIDYMIUM (D-2-164ex): A detailed study of didymium materials, including properties and chemistry.

FABRICATION OF SINTERED RARE EARTH OXIDES (R-8-659 Reprinted 759): A description of the fabrication procedure and forming and sintering characteristics of various rare earth oxides fired at 1800° F and 2700° F.

HIGH PURITY RARE EARTH & YTTRIUM SALTS (PS-3-365ex): A brief description of high purity materials, including methods of preparation, and impurities.

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THE RARE EARTHS, ed. by F. H. Spedding and A. H. Daane, John Wiley & Sons, Inc., New York (1961).

> Published under the auspices of the American Society for Metals in cooperation with the Office of Technical Information, United States Atomic Energy Commission.

RARE EARTH ALLOYS, Karl A. Gschneidner, Jr., D. Van Nostrand Co., Inc., Princeton, N.J. (1961).

> A critical review of the alloy systems of the rare earth, scandium, and yttrium metals, published under the auspices of the Office of Technical Information, United States Atomic Energy Commission.

RARE EARTH ELEMENTS, ed. by D. I. Ryabchikov, published by the Academy of Sciences, USSR, Moscow (1959). Translation from the Russian by the Israel Program for Scientific Translations for the National Science Foundation and the Department of Commerce (1960).

> Available as OTS 60-21172 from the Office of Technical Services, U.S. Department of Commerce, Washington, D.C. 20025. A collection of papers on Russian technology composed mainly of papers presented at the Conference on Extraction, Analysis, and Application of the Rare Earth Elements, held in June 1956, at the Institute of Geochemistry and Analytical Chemistry of the Academy of Sciences of the USSR.

TECHNICAL DATA

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TECHNICAL PUBLICATIONS

The Rare Earth Division has published a wealth of technical information that is available at no charge to interested firms and individuals. The following is a list of these bulletins:

TECHNICAL BINDER: A complete description of all of our thorium, rare earth, and yttrium chemicals. Typical analyses and price information are included.

ABSORPTION SPECTRA (R-4-160): Absorption curves of separated rare earths and rare earth mixtures.

CATALYST USES (R-3-1259): A bibliography of the technical literature where rare earth materials have been used as catalysts and as catalyst promoters and activators.

CERIUM OXIDE (C-3-760): A comprehensive study of various cerium compounds -- properties, uses, and chemistry.

DIDYMIUM (D-2-164ex): A detailed study of didymium materials, including properties and chemistry.

FABRICATION OF SINTERED RARE EARTH OXIDES (R-8-659 Reprinted 759): A description of the fabrication procedure and forming and sintering characteristics of various rare earth oxides fired at 1800° F and 2700° F.

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ANALYTICAL CHEMISTRY OF THE RARE EARTHS, R. C. Vickery, vol. 3 of International Series of Monographs on Analytical Chemistry, Pergamon Press, Oxford (1961).

THE RARE EARTHS AND RARE EARTH COMPOUNDS, M. M. Woyski and R. E. Harris, chapter in vol. 8, pp. 1-146, Kolthoff and Elving's Treatise on Analytical Chemistry, Part II, Interscience Publishers, New York (1963).

THORIUM PRODUCTION TECHNOLOGY, F. L. Cuthbert, Addison-Wesley Publishing Co., Inc., Reading, Mass. (1958).

CERIUM, W. L. Silvernail and R. M. Healy, chapter in vol. 4, pp. 840-854, Kirk-Othmer's Encyclopedia of Chemical Technology, Interscience Encyclopedia, Inc., New York (1964).

GAS MANTLES, H. E. Kremers, chapter in vol. 8, pp. 192-197, Kirk-Othmer's Encyclopedia of Chemical Technology, Interscience Encyclopedia, Inc., New York (1952).

RARE EARTH METALS, ALLOYS, AND COMPOUNDS, H. E. Kremers, chapter in vol. 11, pp. 503-521, Kirk-Othmer's Encyclopedia of Chemical Technology, Interscience Encyclopedia, Inc., New York (1953).

RARE EARTH METALS, chapter in C. A. Hampel, "Rare Metals Handbook", Reinhold Publishing Corp., New York (1961).

THE CHEMISTRY OF THE LANTHANIDES, Therald Moeller, Reinhold Publishing Corp., New York (1963).

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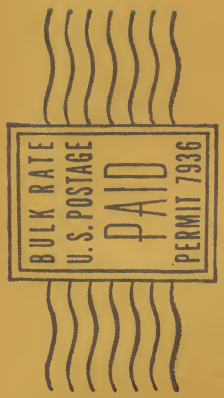

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